

ESTIMATION OF RATES OF TAG
SHEDDING BY NORTHWEST ATLANTIC
BLUEFIN TUNA¹

A joint experiment was initiated by the Fisheries Research Board of Canada (FRBC), the National Marine Fisheries Service, and the Woods Hole Oceanographic Institution (WHOI) in 1971 under the leadership of F. Mather to estimate the rates of tag shedding by bluefin tuna. Five hundred and eighty bluefin tuna were double tagged with one of four types of dart tags off the east coast of the U.S. during the 1971 fishing season. Two types of darts, metal and plastic, were used and tags supplied by FRBC were slightly different from tags supplied by WHOI. Tags and tagging procedures

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TABLE 1.—Tag releases and returns from east coast of U.S. bluefin tuna double tag study.

Agency and tag type	1971 Double tag releases	1971 First year returns			1972 Second year returns		
		n_{dd1}	n_{ds1}	t_1 (days)	n_{dd2}	n_{ds2}	t_2 (days)
FRBC							
Plastic dart	140	16	1	24.4	7	8	369.8
Metal dart	128	9	1	19.4	9	11	376.0
WHOI							
Plastic dart	150	4	0	7.2	20	9	349.9
Metal dart	162	4	1	18.6	10	9	371.1
Total							
Plastic dart	290	20	1	19.8	27	17	357.3
Metal dart	290	13	2	19.1	19	20	373.7
Total	580	33	3	19.5	46	37	364.7

were those described by the Food and Agriculture Organization (1972). The 1971 releases and returns in 1971 and 1972 are shown in Table 1 by tagging agency and dart type.

The notation and methodology in this study follows Bayliff and Mobrand (1972):

$$n_{ddk} = F\tau N_D \pi \rho^2 e^{-(F+X+2L)t_k}$$

$$n_{dsk} = F\tau N_D \pi \rho (1 - \rho e^{-Lt_k}) e^{-(F+X+L)t_k}$$

where:

t_k = time at the middle of the k th period of length τ ($k = 1, 2$),

n_{ddk} = number of returns of double-tagged fish retaining both tags during the period centered at t_k ,

n_{dsk} = number of returns of double-tagged fish retaining only one tag during the period entered at t_k ,

N_D = number of fish released with double tags,

π = portion of tagged fish which remain alive after the Type-I (immediate) mortality has taken place,

ρ = portion of the tags which are retained after Type-I (immediate) shedding has taken place,

F = instantaneous rate of fishing mortality,

X = instantaneous rate of other mortality (other includes natural mortality, Type-II (long-term) tagging mortality and apparent mortality caused by migration from the fishery), and

L = instantaneous rate of shedding of tags.

Bayliff and Mobrand showed that

$$\ln \frac{2n_{ddk}}{n_{dsk} + 2n_{ddk}} = -Lt_k + \ln \rho = Y_k$$

where Y_k is an estimate of the log of the proportion of tags retained up to time t_k .

Estimates of Y_k are shown in Table 2. Estimates of L and ρ are shown in Table 3. Although some differences among categories are indicated, a chi square test for differences in returns among categories was not significant at the 90% level of confidence. Thus the differences do not appear to be large enough to rule out the use of

TABLE 2.—Intermediate results in estimates of shedding rates from 1971 U.S. east coast bluefin double tag study.

Agency and tag type	Y_1	Y_2
FRBC		
Plastic dart	-0.03077	-0.45199
Metal dart	-0.05407	-0.47692
WHOI		
Plastic dart	0	-0.20294
Metal dart	-0.11778	-0.37156
Total		
Plastic dart	-0.02469	-0.27370
Metal dart	-0.07411	-0.42286
Total	-0.04445	-0.33802

TABLE 3.—Estimates of ρ and L from 1971 U.S. east coast bluefin double tagging study.

Agency and tag type	$\ln \rho$	L on daily basis	ρ	L (on annual basis)
FRBC				
Plastic dart	-0.00102	0.0012195	0.999	0.44512
Metal dart	-0.03106	0.0011858	0.969	0.43282
WHOI				
Plastic dart	0.00426	0.0005922	1.004	0.21615
Metal dart	-0.10439	0.0007199	0.901	0.26278
Total				
Plastic dart	-0.01008	0.0007378	0.990	0.26929
Metal dart	-0.05532	0.0009835	0.946	0.35898
Total	-0.02787	0.0008504	0.973	0.31041

the estimates obtained from the combined data. These estimates of $\rho = 0.973$ and $L = 0.31041$ are close to the estimates of Bayliff and Mobernd (1972) of $\rho = 0.913$ and $L = 0.278$ for yellowfin tuna in the eastern Pacific.

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